ABSTRACT

The composite material of the invention is constituted by a thermoplastic film (2) having a multiplicity of perforation craters (4) of small dimensions on one of its faces and whose smooth, other face is covered in fibers (3) most of which are thermoplastic and that are bonded to one another and to the film (3) in substantially continuous manner. The material is usable as a breathing film for absorbent hygiene articles, in particular diapers. A method of manufacture consists: a) in dispersing a sheet of fibers (3) most of which are thermoplastic onto a thermoplastic film (2), or in extruding a thermoplastic film onto a non-woven fabric made of such fibers; b) in presenting the fiber/film composite onto a surface that is provided with orifices; and c) in heating to a temperature close to the softening temperature of the two thermoplastic materials while simultaneously establishing suction through the orifices so as to cause the film overlying said orifices to puncture. The method may include a prior step of pre-coating with adhesive, which step may be implemented, in particular, by the melt-blown technique at a rate of 0.2 g/m^2 to 5 g/m^2 of adhesive.

A COMPOSITE PLANE MATERIAL INCLUDING A PERFORATED FILM AND THERMOPLASTIC FIBERS, USE THEREOF AND METHOD OF MANUFACTURE

The present invention relates to a composite plane fiber material in which a film is covered with fibers which are bonded to one another and also to the film. It also relates to the use of said material as an air-permeable film that is preferably, but not exclusively, capable of being impermeable to liquids, in particular in hygiene articles, e.g. disposable diapers or nappies and sanitary napkins or towels. It also relates to a method of manufacture specially designed for producing said composite plane fiber material.

In diapers, the absorbent wad is generally placed on a film that is impermeable to liquids and that serves both to support said wad, enabling it to be put in place and closed on the user, and also serving as a barrier to urine. When the article is left in place on the user and the absorbent wad is wet with urine, the urine often soaks through to come into contact with the skin of the user, thereby giving rise to rashes or even to allergies. Proposals have already been made to remedy this situation by using a film to support the absorbent wad, where the film is both impermeable to liquids while being also permeable to air and to water vapor. The film thus acts as a barrier to urine while allowing gas exchange to take place between the inside of the article and the outside, thereby enabling the urine contained in the absorbent wad to be progressively eliminated in the form of water vapor.

One such film, having the properties of being impermeable to liquids and of being permeable to air and water vapor is generally made from a microporous material that is known commercially under the name Goretex. The cost of that material is very high. In addition, in the opinion of the Applicant, its feel is not very agreeable.

For sanitary napkins, the absorbent wad is surrounded by a film that must enable blood to pass in, but not back out. For this purpose, proposals have already been made for a perforated film in which the perforations are in the form of craters, with the projections of the craters being on the face that comes into contact with the absorbent wad. Here again, the feel of such a material is not agreeable.

The object of the Applicant is to provide a composite plane material that is capable of mitigating the drawbacks of the above-mentioned films.

This object is fully achieved by the composite plane material of the invention. In characteristic manner, this material is constituted by a perforated thermoplastic film which has a multiplicity of small-sized perforation craters on one face and whose opposite face is smooth and is covered with fibers, most of which are thermoplastic fibers; the fibers are bonded to one another and to the film in substantially continuous manner.

The bonding of the fibers on the film must not give rise to crushed spots of the kind described in document EP 0 403 187, since they give rise to harmful deformation of the craters and to non-uniformity in the fiber sheet. In that document it should be observed that the sheet of fibers is not bonded to the smooth face as in the present invention, but to the face that has the craters.

The fibers are preferably bonded to one another and to the film, even on the walls of said craters.

Permeability to air and to water vapor is obtained by the presence of the perforations that allow gas exchange to take place between the faces of said material. The chosen dimensions, number, and shape of the perforations serve, where appropriate, to ensure that the thermoplastic film remains impermeable to liquids, or to obtain permeability to liquids in one direction only. The presence of fibers on the surface of the

thermoplastic film provides the material of the invention with a fiber feel that is more agreeable.

The fibers cover the smooth face of the thermoplastic film, i.e. the face which corresponds to the inside walls of the craters. The concept of inside wall and "outside" wall as applied to a crater will become more clear from the description given below of a particular embodiment.

The plane material of the invention preferably includes perorations at a density lying in the range 10 per cm² to 100 per cm², with the size of said perforations lying in the range 0.1 mm to 1.5 mm.

The fibers are bonded to one another and to the film by virtue of the thermoplasticity of the raw materials thereof. It is therefore necessary for most of the fibers to be thermoplastic fibers, so that the composite material of the invention has sufficient cohesion between the film and the fibers.

The perforated thermoplastic film may also be covered with thermoplastic fibers that are bonded to one another and to the film in substantially continuous manner on the opposite face, i.e. on the face that has the perforations craters on its surface. Under such circumstances, both faces present an agreeable fiber feel.

The raw material from which the thermoplastic fibers and the film are made is preferably the same, e.g. polyethylene. Nevertheless, the film could be made of some other material such as polyamide or polypropylene, or a mixture of polyethylene and of ethylene vinyl acetate (EVA). The thermoplastics fibers may be made of polypropylene.

In a variant, the fibers are bonded to one another and to the film by the presence of an adhesive, in combination with the thermoplasticity of the raw materials constituting the fibers and the film. Under

such circumstances, it is possible to use raw materials having melting points that are significantly different.

The quantity of adhesive must be relatively low so as to avoid spoiling the flexibility of the composite material. It preferably lies in the range 0.2 grams per square meter (g/m^2) to 5 g/m^2 for a weight of fibers lying in the range 2 g/m^2 to 20 g/m^2.

The composite fiber material is advantageously used as a "breathing" film in the manufacture of absorbent hygiene articles, in particular disposable diapers and sanitary napkins. It relates in particular to a breathing film serving as a support or covering for the absorbent wad.

The invention also provides a first method of manufacturing the above-specified composite plane fiber material. The method consists:

a) in dispersing a sheet of fibers most of which are thermoplastic on a thermoplastic film optionally precoated with adhesiv

b) in presenting the assembly made up in this way on a surface that is provided with orifices, and

c) in heating said assembly to a temperature close to the softening temperature of the thermoplastic materials constituting the fibers and the film while simultaneously establishing suction through the orifice, so as to cause the film over said orifices to puncture.

The heating of the film/fiber assembly serves both to soften the film in the zones corresponding to the orifices and also to obtain bonding between the fibers and between the fibers and the film in substantially continuous manner at the points of contact between those various parts. In particular, it is observed that the walls of the craters formed during puncturing of the film under the effect of air being sucked through the orifices can constitute privileged zones for bonding between the fibers and the film.

The fibers can be dispersed in the form of a sheet over the surface of the thermoplastic film by any appropriate means, in particular by spraying on the fibers using the cut fiber technique, or the spun technique, or indeed using the melt-blown technique.

In a preferred version, the manufacturing method is a continuous method and the surface on which the film/fiber assembly is presented is constituted by the peripheral surface of a rotary drum fitted with an internal suction system.

The heating of the film/fiber assembly can be performed in particular by means of radiant panels located above the surface of the drum, over that portion thereof that is fitted with the suction system.

A composite plane fiber material of the invention can also be obtained using a second method in which a sheet of thermoplastic fibers is dispersed over a perforated thermoplastic film which has a multiplicity of small-sized perforation craters on one of its faces, the fibers being dispersed at least over the smooth other face of the film while the fibers are at a temperature that is high enough to cause them to adhere naturally to the surface of the film after it has cooled.

Under such circumstances, the film is covered uniformly by the sheet of fibers and the fibers are point bonded to one another and to the film solely because of the thermoplasticity of the materials, bonding taking place on the surface of the film with the exception of its craters.

In order to be certain that the fibers do indeed bond to one another and to the surface of the film, a variant of the above-specified method consists in pre-coating the smooth face of the perforated thermoplastic film with adhesive that withstands said temperature. The adhesive is preferably likewise a thermoplastic polymer, suitable for application by the melt-blown technique.

The invention also provides a third method of manufacturing the above-mentioned composite plane fiber material. This method consists:

a) in extruding a thermoplastic film on a non-woven fabric constituted by a sheet of fibers most of which are thermoplastic;

b) in presenting the assembly constituted in this way onto a surface that is provided with orifices; and

c) in heating said assembly to a temperature close to the softening temperature for the thermoplastic materials constituting the fibers and the film while simultaneously establishing suction through the orifices so as to cause the film overlying said orifices to puncture.

Compared with the first above-mentioned method, the first step makes use of a non-woven fabric instead of a thermoplastic film as the pre-existing support medium. In this case, it turns out that there is no longer any need to consider coating with adhesive insofar as highly effective bonding is obtained between the fibers and the film merely by applying the film during extrusion directly onto the non-woven fabric.

The present invention will be better understood on reading the following description of two embodiments of a film/fiber composite material of perforated polyethylene shown in the accompanying drawings, in which:

Figure 1 is a diagrammatic section view of one type of composite material;

Figures 2A, 2B, 2C, and 2D are diagrammatic section views through different fiber configurations in a crater zone;

Figures 3 and 4 are diagrams showing two installations for manufacturing said composite material; and

Figure 5 is a diagrammatic section view through another type of composite material.

The composite material 1 characteristic of the invention is made up of a thermoplastic film 2 that is covered on one of its faces with fibers 3 that are mostly thermoplastic fibers. The composite material 1 includes a multiplicity of perforations which are substantially crater-shaped, as can be seen clearly from Figure 1.

The fibers 3 are bonded to one another and to the film, at least in the smooth zones 24 of the film which, on the face of the film opposite from the craters 4, corresponds to the plane zones excluding the inside walls 5 of the craters 4. The fibers 3 are bonded to one another and to the film 2 in substantially continuous manner, i.e. without any spots where the fibers are crushed or where the craters are deformed.

The fibers 3 may also be bonded to one another and to the film 2 on the walls 5 of the craters 4.

More precisely, Figures 2A, 2B, 2C, and 2D are diagrams showing four configurations that can be taken up by the fibers 3 where they overlie a crater 4.

In the first configuration (Figure 2A), the fibers 3a overlie the walls 5 of the crater 4, while leaving the orifice 6 of the crater open.

In the second configuration (Figure 2B), the fibers 3b overlie the walls 5 of the crater 4 and at least some of them cross from one wall 5a to the opposite wall 5b, thereby obstructing the orifice 6, at least in part, in a zone 7 of the crater that corresponds to the apex of said crater.

In a third configuration (Figure 2C), fibers 3a overlie the walls 5 of the crater 4 as in the first configuration. However, there are also other fibers 3c that extend over the crater 4 substantially in the same plane as the other fibers in the non-perforated zones of the non-composite meterial 1.

In a fourth configuration (Figure 2D), the fibers 3d extend solely over the crater 4, remaining substantially

in the same plane as the other fibers in the smooth zones 24.

A single composite material 1 of the invention may naturally include craters whose fiber coverings correspond to one or more of the above-specified four configurations, and indeed they may be covered in other types of configuration, depending in particular on the method of manufacture. For example, it is possible to ensure that there are no fibers overlying a crater 4, e.g. as shown in Figure 2a, and also that there are no fibers on the inside walls of the crater 4.

The predominance of one or other of the configurations depends on the conditions under which the composite material is manufactured, as appears more clearly from the description below.

Figure 3 is a highly diagrammatic representation of a first installation 29 for manufacturing the composite material shown in Figures 1 and 2.

The installation 29 includes means for feeding a plastic film 2, e.g. a polyethylene film. These means may be constituted by a shaft 8 rotated by drive means (not shown) and having a roll 9 fitted thereon that is constituted by a reel of film 2.

On the path of the film 2, the installation 29 includes apparatus 10 for spraying on fibers 3, said apparatus being disposed above a conveyor 11 suitable for supporting the film 2 during said operation of building up a sheet of fibers 3 on the top face of said film 2.

The installation 29 also includes a rotary drum 12 that is rotatable about a shaft 13, and that is rotated by conventional means (not shown). The periphery of the drum includes a multiplicity of orifices 14.

The drum 12 is a hollow cylinder having a suction chamber 15 formed therein. The chamber 15 is substantially airtight and is defined by an inside wall 16 which is stationary and by a fraction 17 of the drum

12. Known suction generation means (not shown), e.g. a fan, communicate with said chamber 15.

The installation 29 also includes a set of radiant panels 18 disposed in a circular arc above the portion 17 of the drum 12 that overlies the suction chamber 15.

Finally, the installation 29 includes reception means 29 for taking up the composite material 1.

The installation 29 operates as follows. The thermoplastic film 2 is placed on the conveyor 11. The spray apparatus 10 builds up a continuous and uniform sheet of fibers 3 on the top face of the film 2, which fibers are merely placed on the film 2 without any particular bonding to the film. The assembly constituted by the film 2 and the sheet of fibers 3 is brought onto the drum 12 and is pressed thereagainst substantially over its entire portion 17 overlying the suction chamber 15, prior to being wound onto the reception device 19. While the film/fiber assembly is moving over the drum 12 as the shaft 13 of the drum rotates, it is simultaneously subjected to the heating action of the radiant panels 18 and to the suction action of the chamber 15.

The effect of the heating action is to raise the film/fiber assembly to a temperature close to the softening temperature of the thermoplastic raw materials constituting both the film 2 and the fibers 3.

Because of the presence of orifices 14 in the drum 12, the effect of the suction is not only to press the film 2 against the surface of said drum 12 but also to create perforations through the film/fiber assembly. Since the thermoplastic film 2 is very close to its softening state, the suction forces cause the zones of the film that overlie the orifices 14 to be deformed; this deformation (which is a kind of blistering) continues until the blisters burst and then take up a crater shape. The film 2 is thus pierced merely under the mechanical effect of the suction.

The fibers 3 situated on the surface of the film 2 are likewise softened while the craters 4 are being formed and they are entrained to a greater or lesser extent during deformation of the film 2. This entraining of the fibers 3 occurs to a greater or lesser extent depending on various operating conditions, in particular the heating temperature, the pressure that may possibly be exerted to press the fibers 3 onto the film 2, the length of the fibers 3, the content of non-thermoplastic fibers in the fiber mix, the difference between the softening temperature of the fibers 3 and that of the film 2, etc. Thus, while the blisters are being created, a greater or less quantity of fibers remains bonded to the inside walls of each blister, so that after the blister has burst, a crater 4 is formed with said fibers covering the inside walls 4 of the blister. That explains the various different configurations shown in Figures 2a, 2B, 2C, and 2D.

It may be preferable to place an adhesive spraying apparatus 25 on the path of the thermoplastic film 2 upstream from the fiber spraying apparatus 10, thereby depositing a small and uniform quantity of adhesive over the entire top face of the film 2. The device may be of the melt-blown type projecting adhesive 26 in the form of an adhesive thermoplastic resin.

The amount of adhesive applied must be sufficient to improve bonding between the fibers and between the fibers and the film while nevertheless being small enough to avoid spoiling the flexibility of the material of the invention. It is also a function of the quantity of fibers 3 deposited on the film 2; the preferred range of adhesive is 0.2 grams per square meter (g/m^2) to 5 g/m^2 and corresponds to the weight of fibers being in the range 2 g/m^2 to 20 g/m^2.

In a variant embodiment, the composite material of the invention may be manufactured on a second installation as shown diagrammatically in Figure 4. For

simplification purposes, the same references are used to designate elements that are common to both installations 29 and 30.

The shaft 8 has a roll 31 fitted thereon that comprises a reel of non-woven fabric 32 that comprises a sheet of fibers, most of which are thermoplastic fibers.

On the path of the non-woven fabric 32, the installation 30 includes apparatus 33 for extruding a thermoplastic film 34. The extruder apparatus 33 is disposed above a conveyor 11 suitable for supporting the fabric 32 while the film 34 is being extruded on the top face of said fabric 32.

The installation 30 includes the same rotary drum 12 that is perforated and provided with suction means and the same radiant panels 18 as described above for the installation 29. However, the drum 12 must be disposed in such a manner that it is the thermoplastic film 34 that comes into contact with the portion 17 of the drum 12 overlying the suction chamber 15, so the relative disposition is reversed as compared with the installation 29.

The installation 30 operates as follows. The non-woven fabric 32 is placed on the conveyor 11. The apparatus 33 extrudes the thermoplastic film 34 which is immediately applied to the top face of the fabric 32 before it has had time to cool down completely. This ensures a certain amount of bonding between the fibers of the fabric 32 and the film 34.

The other steps are identical to those described above for the installation 29.

In the present case, because the thermoplastic film is extruded onto a sheet of fibers that have already been consolidated, it is found that after the composite has gone past the rotary drum, the fibers of the non-woven fabric in zones that overlie the craters are not only generally unconnected with the film on the inside walls

of the craters, but also they are moved apart from one another so as to form holes over the craters.

Naturally it would be possible to obtain the composite material of the invention using techniques other than those described above, for example by implementing the needling technique. However, the method described above has the advantage of making it possible, by adjusting operating conditions, to obtain a variety of different products all based on the same concept, which variety is much larger than that which could be obtained by implementing the needling technique.

It is also possible to disperse the fibers over a film that has already been perforated. Under such circumstances, the fibers must be dispersed over the face of the film that does not include the craters, with the fibers being under conditions of temperature such that after cooling they adhere to one another and to the smooth zones 24 of the film. Such conditions can be obtained by extruding the fibers directly over the film as it moves continuously and by projecting said fibers onto the film while they are still at a temperature that is above the melting temperature of the thermoplastic material from which they are made. The resulting material will be mostly of the configuration shown in Figure 2D.

Under such circumstances, it is also preferable to pre-coat an adhesive onto the face of the film onto which the fibers are projected. By way of example, the adhesive may be a thermoplastic adhesive resin that reacts at the temperature at which the fibers come into contact with the film.

In the above example, a fiber covering is applied only to the face of the film which corresponds to the inside walls 5 of the craters 4. The invention is not limited to that configuration. Figure 5 shows an example of a material in which a first fiber surface 20 lies on the face 21a of the film 21 which corresponds to the

outside walls 22 of the craters 23, while a second fiber surface 27 is to be found on the face 21b of the film 21 which corresponds to the inside walls 28 of the craters 23. Such a material can be implemented by a first pass through the installation of Figure 3 followed by fibers being sprayed onto the other face being spunbounded directly onto the film.

The composite material of the invention is advantageously used in the manufacture of disposable absorbent hygiene articles. For disposable diapers, it is used as a support sheet for the absorbent wad, with the craters preferably being directed towards the inside of the article. The support thus remains impermeable to liquids and therefore serves as a barrier to prevent urine passing out, however, because of the perforations it is permeable to gas and therefore allows an interchange of air and water vapor between the inside and the outside of the article.

For sanitary napkins, it is used as a sheet that surrounds the absorbent wad, with the craters being directed towards the absorbent wad. The shapes and sizes of the perforations are such that the composite material of the invention is permeable to liquids flowing towards the absorbent wad but not in the opposite direction. In both cases, the presence of fibers confers an agreeable feel to the material of the invention which is very different from the plastic feel of films presently used for supporting or covering the absorbent wad.

The size and density of the perforations depend on the intended application. In a specific example for a hygiene application, in a film having a thickness of about 80 micrometers, perforations were provided at a density of about 50 craters per cm^2, with an open area ratio of 25% (ratio of the apexes of the craters divided by the total area of the film). The film preferably weighs 30 g/m^2 to 40 g/m^2.

It may be advantageous for the thermoplastic film to have a degree of natural elasticity: Under such circumstances, it is preferable for the bonding between the fibers and the film to be performed while the film is in a stretched state. Once the perorated plane fiber material has been made, the film returns to its initial, non-stretched state, so that the fiber covering increases in volume and in bulk, and is in no danger of breaking should the material be stretched again.

The fibers constituting the non-woven fabric may be polymers such as polypropylene or polyethylene, for example, or they may constitute a mix of different types of polymers or a mix of synthetic fibers and natural or artificial fibers, e.g. viscose. Bi-component fibers may also comprise a solution for making up a fiber wad.

The present invention is not limited to the embodiments described above by way of non-exhaustive example. In particular, the thermoplastic film may be made of polyethylene, of polyamide, of EVA, of polypropylene, or of a mixture of those materials obtained by coextrusion or in a single layer.

CLAIMS

1/ A composite plane material constituted by a thermoplastic film (2) covered in fibers, most of which are thermoplastic and that are bonded to one another and to the film, said film having a multiplicity of craters (4) of small dimensions on one of its faces, the material being characterized in that the fibers are bonded to the film in substantially continuous manner over the smooth face thereof.

2/ A material according to claim 1, characterized in that the fibers (3) are bonded to one another and to the film, even on the inside walls (5) of the craters (4).

3/ A material according to claim 1 or 2, characterized in that it includes perforations at a density lying in the range 10 per cm^2 to 100 per cm^2, the size of said perforations lying in the range 0.1 mm to 1.5 mm.

4/ A material according to claim 1, characterized in that the thermoplastic film (21) is covered with fibers (20) most of which are thermoplastic and that are bonded to one another and to the film also on the other face (21a) that has the perforation craters (23).

5/ The use of the composite plane material according to any one of claims 1 to 4, as a breathing film in the manufacture of absorbent hygiene articles, in particular diapers and sanitary napkins.

6/ A method of manufacturing a composite plane fiber material according to claim 1, characterized in that it consists:

a) in dispersing a sheet of fibers (3) most of which are thermoplastic on a thermoplastic film (2);

b) in presenting the assembly made up in this way on a surface (12) that is provided with orifices (14); and

c) in heating said assembly to a temperature close to the softening temperature of the thermoplastic materials constituting the fibers (3) and the film (2) while simultaneously establishing suction through the orifice, so as to cause the film over said orifices to puncture.

7/ A method of manufacturing a composite plane fiber material according to claim 1, characterized in that it consists in dispersing a sheet of thermoplastic fibers on a perforated thermoplastic film having a multiplicity of perforation craters of small dimensions on one of its faces, the fibers being dispersed at least over the smooth, other face of the film while the fibers are at a temperature that is sufficiently high to cause them to adhere naturally to the surface of the film after cooling.

8/ A method according to claim 6 or 7, characterized in that it includes a prior step of pre-coating adhesive on the face of the film (2) onto which the fibers (3) are dispersed.

9/ A method according to claim 8 , characterized in that the adhesive is a thermoplastic adhesive resin that reacts at the temperature at which the fibers come into contact with the film.

10/ A method according to claim 9, characterized in that the pre-coating is implemented by the melt-blown technique at a rate of 0.2 g/m^2 to 5 g/m^2 of adhesive.

11/ A method according to claim 6 or 7, characterized in that it consists in stretching the thermoplastic film while the fibers are being dispersed on said film.